

# UPS CNG Truck Fleet

## DOE/NREL Truck Evaluation Projects

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Battelle

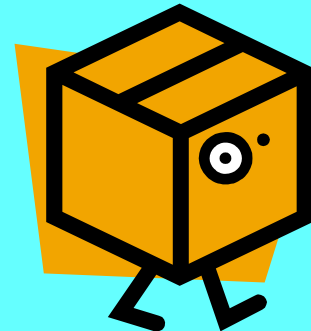
Presented at the NGVTF

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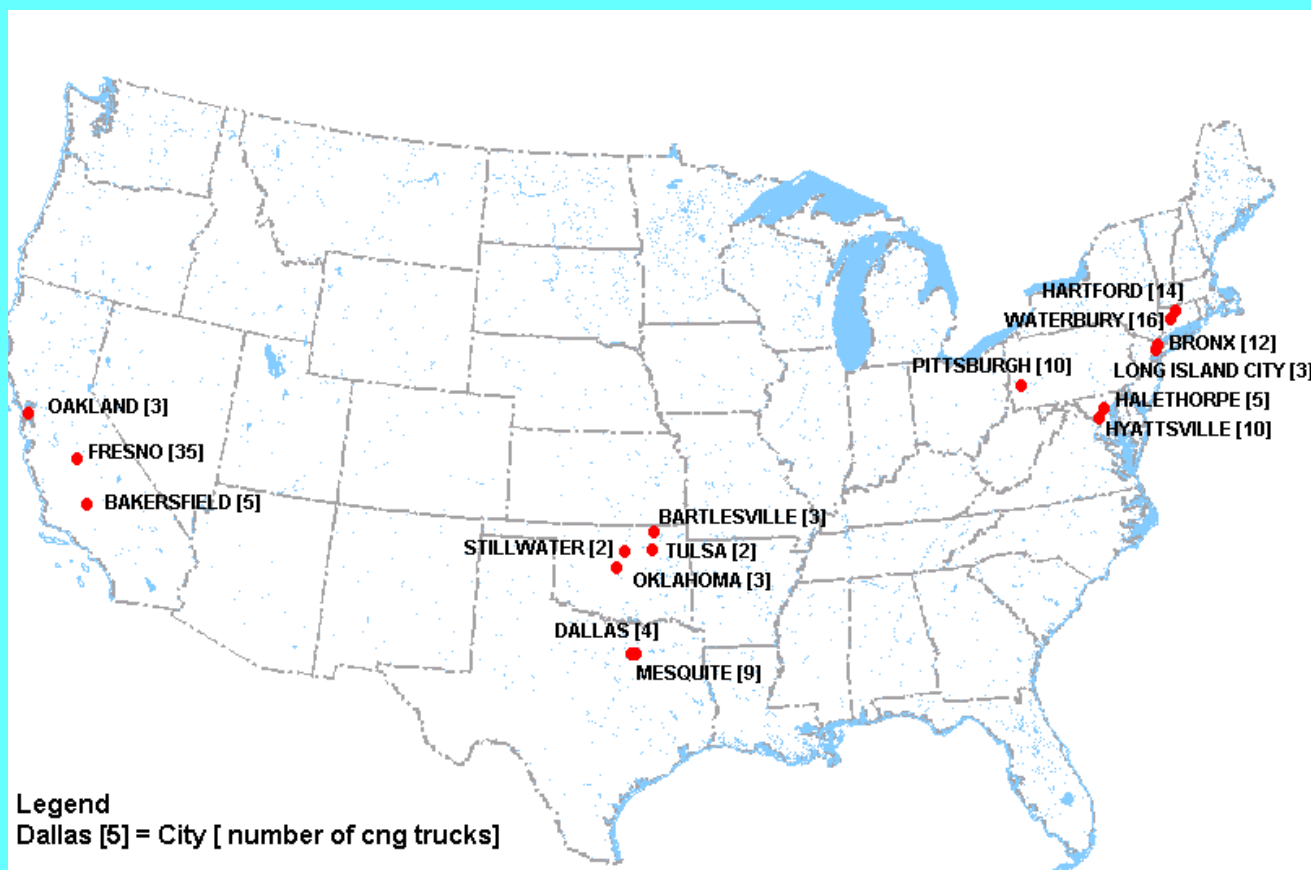
# Fleet Profile

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- United Parcel Service (UPS) is the world's largest express carrier and package delivery company, delivering more than 3 billion packages and documents every year to more than 200 countries and territories.
- In 1989, UPS began testing compressed natural gas (CNG) to assess its viability and benefits as an alternative fuel.
- Today, UPS has the largest private fleet of CNG vehicles in the U.S.—more than 1,000 package delivery vehicles operating in 16 states.



# Freightliner CNG Package Cars



# Project Objectives

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- The objective of this project was to provide transportation professionals with quantitative, unbiased information on the cost, maintenance, operational, and emissions characteristics of CNG as one alternative to conventional diesel fuel for heavy duty trucking applications



# Method

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- Data were collected for the UPS CNG truck operations in Hartford and Waterbury, Connecticut and diesel control vehicles in Windsor, Connecticut between January 1997 and October 2000
- The evaluation included a comparison of
  - Operations
  - Maintenance
  - Performance
  - Emissions Characteristics
- In general, these data were already collected as part of normal business operations



# Vehicle System Descriptions

- Vehicles from the CNG and diesel control fleets had nearly identical chassis and transmissions, while bodies and engine ratings differed somewhat.

Description	Diesel Control	CNG
Chassis Manufacturer	Freightliner	Freightliner
Chassis Model Year	1996	1997
Body Manufacturer/Model	Union City/MT14FD	Grumman Olson/MT45
Engine Manufacturer/Model	Cummins/B5.9	Cummins/B5.9G
Engine Ratings		
Max. Horsepower	160 hp @2500 rpm	195 hp @ 2800 rpm
Max. Torque	400 lb-ft @ 1700 rpm	420 lb-ft @ 1600 rpm
Fuel System Storage Capacity	35 gallons	17 gasoline gallon equivalent usable – 2 CNG tanks from NGV Systems
Transmission		
Manufacturer/Model	Fuller/FS-4205B, 5 speed Standard	Fuller/FS-4205B, 5 speed Standard
Catalytic Converter Used (Y/N)	No	Yes
Vehicle Cost in Comparison to Diesel	-	+\$15,000

# Vehicle Operating Cycles

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- Delivery trucks are operated 6 days a week for up to 12 hours a day in typical delivery of packages and pickups.
- Windsor and Hartford delivery areas have essentially the same terrain. The Waterbury facility operates in more hilly terrain, and the trucks are operated on longer routes.
- The diesel trucks have a 350- to 400-mile range on a full fill of fuel. The CNG trucks have about a 125-mile range at 3600 psi fuel fill and about a 110-mile range at 3000 psi fuel fill.



# UPS Hartford

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# UPS Waterbury

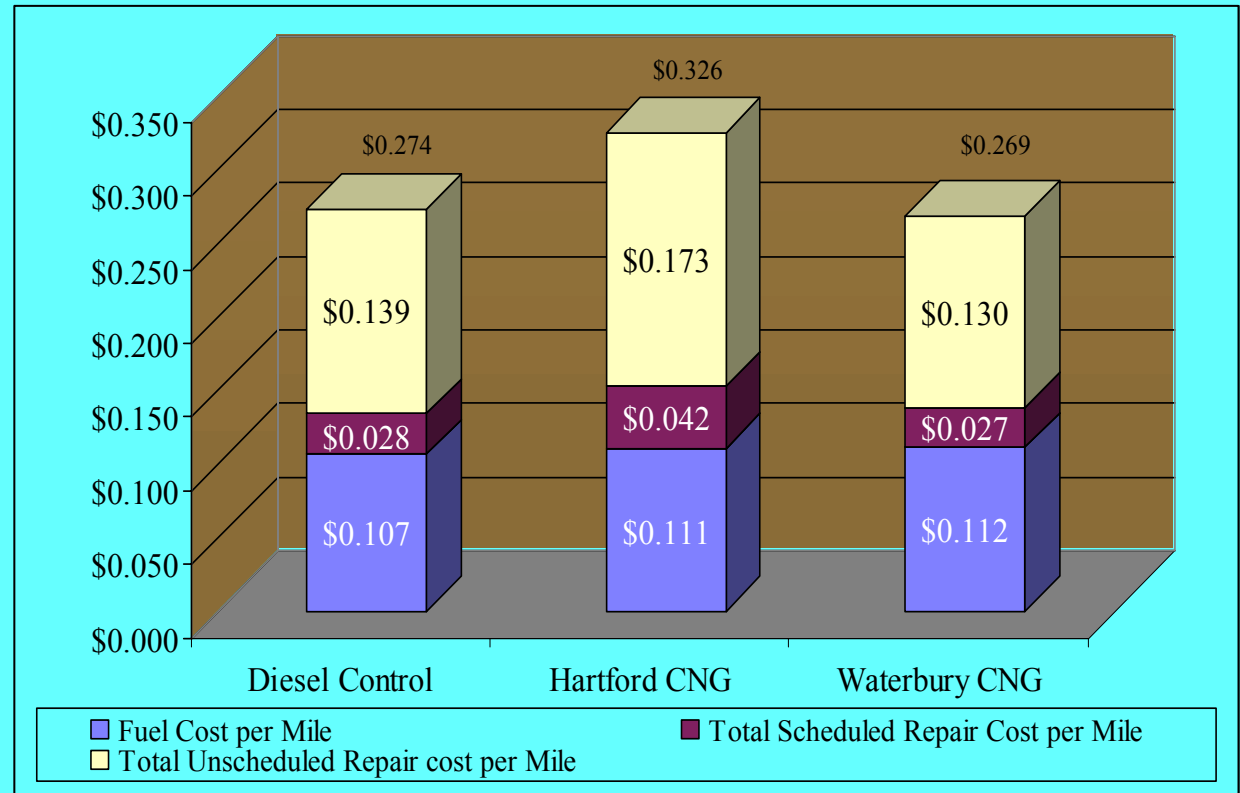
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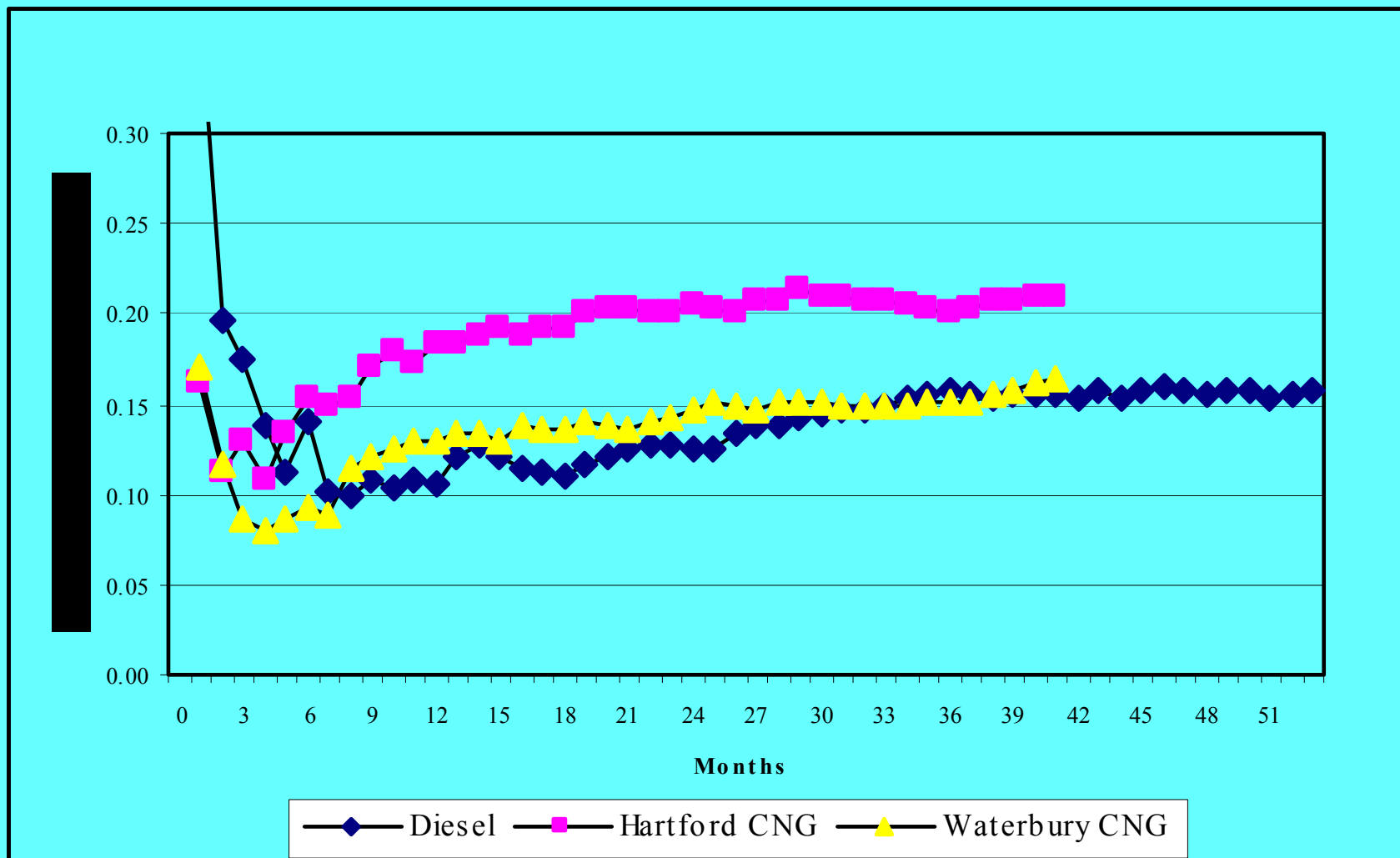
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# Total Operating Costs Comparison

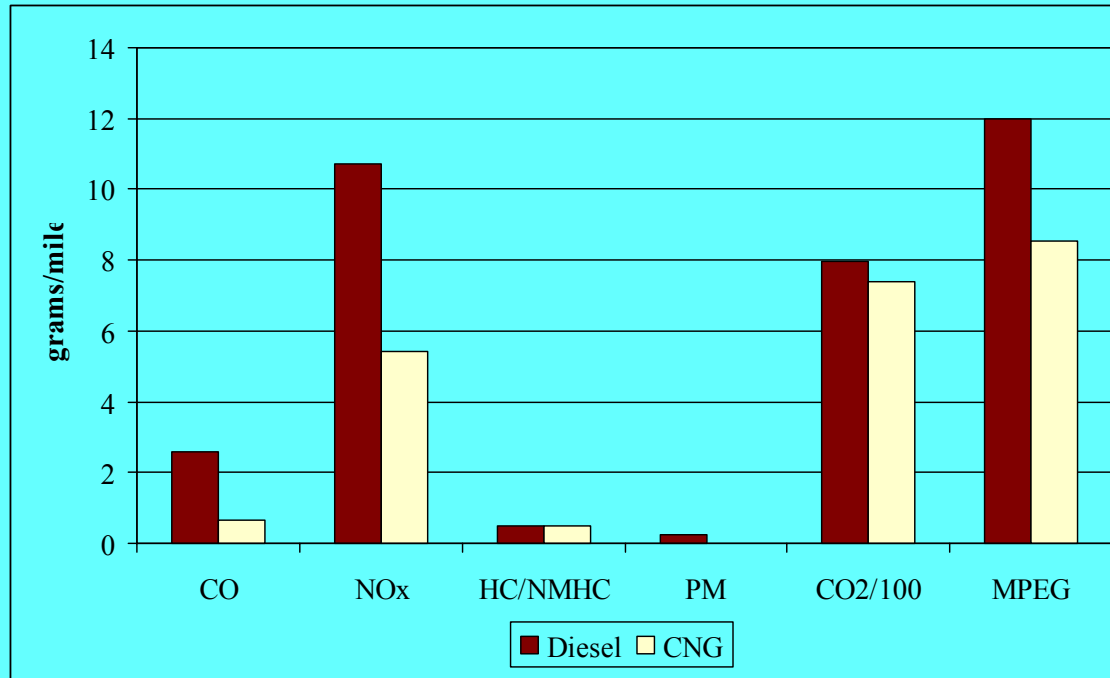
- The Waterbury CNG truck operating costs were consistent with the diesel truck operating costs, but had a higher mileage duty cycle. The Hartford CNG trucks and the diesel trucks had a similar duty cycle and provide a more appropriate comparison.



# Maintenance Cost Results



# Emissions and Fuel Economy Results



- Emissions tests showed that the CNG vehicles had significantly lower levels of CO, NOx, and PM. The CNG vehicles had 29% lower fuel economy during emissions testing, which is consistent with on-road testing results.

# WVU Chassis Dynamometer at UPS

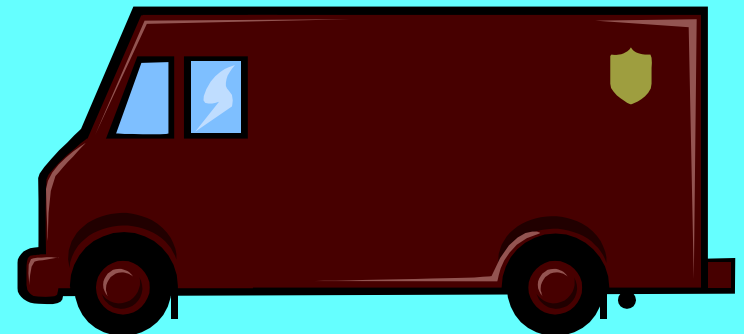
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# Major Conclusions

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- **Reliability:** UPS has been operating the Freightliner CNG package delivery vehicles for nearly 5 years. The CNG trucks operate every working day with no major complaints from maintainers, drivers, or management.
- **Performance:** The CNG truck engine was upgraded before delivery to a slightly higher horsepower and torque rating than the similar diesel vehicles used in the area (including the diesel control vehicles in this study). This upgrade helped overcome the difference in the vehicles.



# Major Conclusions (continued)

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- **Support:** The CNG engine and fuel system used at UPS are early production models. There were problems with spark plugs, spark plug wires, and fuel regulators, some of which were caused by excess compressor oil in the fuel system. Cummins and Freightliner continue to be committed to supporting these products at UPS. Still, newer engine and fuel system technology would likely have had a significant, positive impact in this operating environment.



# Major Conclusions (continued)

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- **Usage:** The CNG delivery trucks are used as much or more than their diesel counterparts. Public refueling in the area might allow them to extend the range of the CNG vehicles on-route, does not currently exist in convenient locations.
- **Fuel Economy:** The fuel economy of the CNG trucks was 27% to 29% lower than the diesel trucks on an energy equivalent basis. This is an expected result for this generation of engines. Newer natural gas technology in this size engine has been shown to have only 10% to 15% lower fuel economy compared with diesel technology in this type of duty cycle.

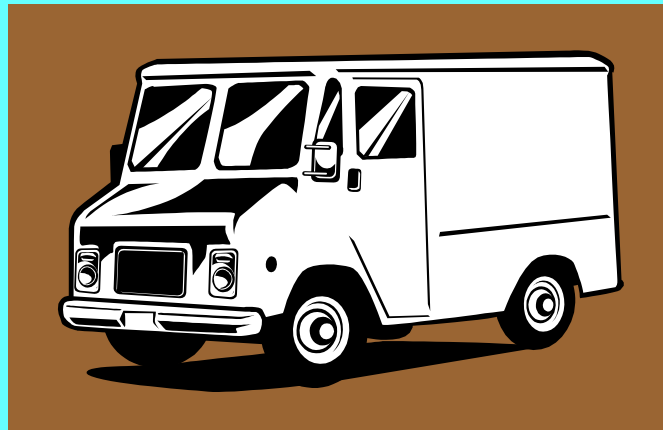




# Major Conclusions (continued)

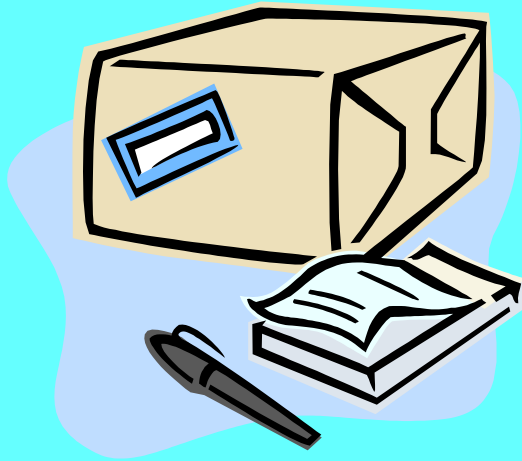
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- **Maintenance Costs:** The maintenance costs were 29% higher for the CNG trucks at the Hartford site compared to the diesel trucks primarily due to engine troubleshooting problems, need for replacement of spark plugs and wires, fuel filter replacements due to oil carryover, and unexpected clutch and transmission repairs. The Waterbury CNG trucks had maintenance costs slightly lower (6% lower) than the diesel trucks. This maintenance cost savings was a result of higher vehicle usage and longer preventive maintenance inspection (PMI) cycles



# Major Conclusions (continued)

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- **Total Operating Costs:** Total operating costs (without driver labor costs) include the fuel and maintenance cost for operating the trucks in service. The CNG trucks at Hartford had 19% higher total operating costs compared to the diesel trucks. The CNG trucks at Waterbury had 2% lower total operating costs compared to the diesel trucks. Improved fuel economy, lower CNG fuel costs, better spark plug and wire life, and lower costs for repair parts would have a positive impact on the cost comparison of the CNG trucks at Hartford with the diesel trucks.

# Comments on UPS Experiences

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- UPS employees like the CNG package delivery vehicles because they have to take them inside to load; the smell is much more desirable.
- UPS is an early adopter of CNG – most of the CNG vehicles are retrofits, all of the CNG vehicles have issues of parts availability.
- UPS would benefit tremendously if the CNG vehicles had longer range (more onboard fuel capacity).

# Comments on UPS Experiences

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- CNG fueling infrastructure – UPS has had significant problems with fueling equipment, Hartford has oil carryover, both sites have equipment from bankrupt vendors, parts are difficult to find and expensive.
- Capital is difficult to use twice for the same thing (long amortization period – 15 years)
- UPS has been committed to CNG vehicles, but would benefit tremendously from the newer available equipment; the problem is who can pay for it.

# Sponsors and Reports

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- This work was done for the U.S. Department of Energy through the National Renewable Energy Laboratory
- This project would not have been possible without the cooperation and support of UPS headquarters and on-site
- Reports are available from the AFDC at 1-800-423-1DOE and the Final Results are available online at:  
[http://www.ctts.nrel.gov/heavy\\_vehicle/pdfs/31227.pdf](http://www.ctts.nrel.gov/heavy_vehicle/pdfs/31227.pdf)

# New NGV Evaluations From DOE/NREL

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- Norcal Waste Systems – Peterbilt Class 8 trucks using Cummins Westport ISX-G (LNG/Diesel); first part of evaluation under way
- Washington Metropolitan Area Transit Authority (WMATA) – New Flyer buses using Cummins C8.3G+ (CNG); evaluation in the planning stage
- City of Los Angeles, Bureau of Sanitation – Peterbilt refuse trucks using Caterpillar C10 dual fuel engines from Clean Air Partners (LNG/Diesel); evaluation just getting under way